# Citrus Tree Roots

## *From Nursery to Field*


**Ute Albrecht**

*ualbrecht@ufl.edu*

Southwest Florida Research and Education Center, Immokalee, FL

University of Florida/IFAS


UF | IFAS UNIVERSITY of FLORIDA

GCA Annual Conference

28 Feb 2022

# What factors influence the citrus tree root structure?

- Genetics
  → the rootstock cultivar

- Environmental factors
  → soil properties

- Other factors
  → propagation, planting

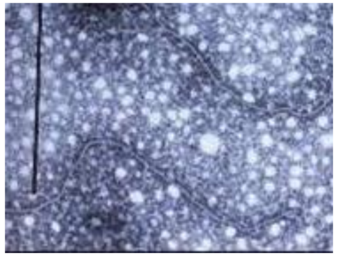
# The Rootstock

The rootstock

# Rootstock selection

Should be based on compatibility with the scion, soil characteristics, pest and disease pressure, desired size control/spacing, and other desired traits



# Tree size effects

# Rootstock freeze tolerance

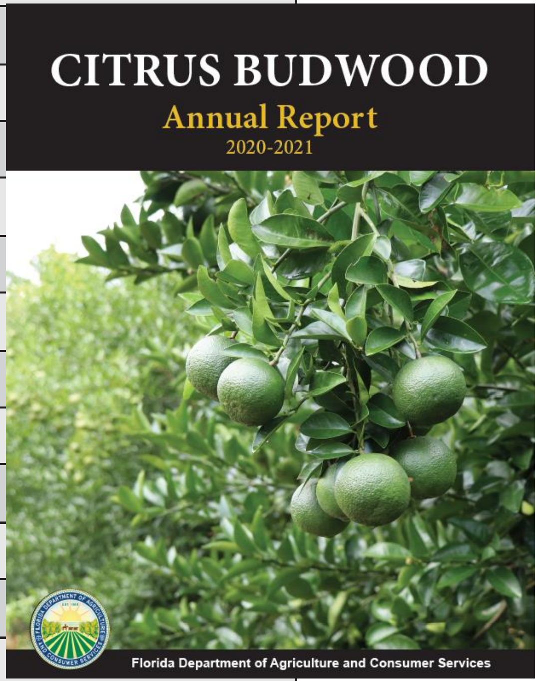
Rootstock tolerance to freeze is highest in trifoliate orange (*Poncirus trifoliata*)

**Trifoliata > TF Hybrids > Sour orange > Lemons**


# The rootstock

## Top 15 Rootstocks 2020-2021

| | 2020 | # Budded | 2019 | 2018 | 2017 | 2016 |
|---|---|---|---|---|---|---|
| 1 | US-942 | 1,285,560 | US-942 | US-942 | Swingle | Kuharske |
| 2 | Kuharske | 841,448 | Kuharske | Swingle | US-942 | X-639 |
| 3 | X-639 | 678,095 | X-639 | Kuharske | X-639 | |
| 4 | Swingle | 468,558 | Swingle | X-639 | Kuharske | |
| 5 | Own Root | 408,793 | US-897 | Sour Orange | Sour Orange | |
| 6 | US-812 | 296,664 | US-812 | US-802 | US-802 | |
| 7 | Sour Orange | 176,322 | Sour Orange | Volkamer | US-897 | |
| 8 | US-897 | 160,288 | US-802 | US-812 | UFR-04 | |
| 9 | Volkamer | 135,977 | Volkamer | US-897 | US-812 | |
| 10 | US-802 | 119,887 | C-54 | Rough Lemon | C-35 | |
| 11 | Rough Lemon | 57,941 | Rough Lemon | C-35 | Cleopatra | |
| 12 | C-35 | 39,142 | UFR-04 | UFR-04 | Volkamer | |
| 13 | C-54 | 26,993 | C-35 | UFR-17 | UFR-03 | |
| 14 | Poncirus trifoliata | 18,106 | C-57 | Poncirus trifoliata | C-22 | |
| 15 | UFR-04 | 17,892 | US-1777 | US-1516 | Carizzo | Rough Lemon |




| Seed | Tissue Culture | Rooted Cutting |
|---|---|---|
| 38 different rootstocks used | 22 different rootstocks used | 17 different rootstocks used |
| 3,550,947 propagations | 650,090 propagations | 208,637 propagations |
| Top Seed = Kuharske | Top Tissue Culture = US 942 | Top Rooted Cutting = US-942 |
| (790,907 Propagations) | (583,560 Propagations) | (60,899 Propagations) |

# The rootstock

- Home
- Credits
- Rootstock Guide
  - Rootstock Table new
  - Notes on Rootstock Traits
- EDIS PDF version
- FDACS Rootstock Data
- Query
- Search Instructions
- FAQs
- What's New
- Contact Us

**Key to Symbols**:
G – Good
H – High
I – Intermediate
L – Low
Lg – Large
P – Poor
R – Resistant

## Citrus Rootstock Selection Guide

Home • Rootstock Table •

Florida Citrus Rootstock Selection Guide, 3rd Edition. William S. Castle, Kim D. Bowman, Jude W. Grosser, Stephen H. Futch and James H. Graham. The authors also wish to gratefully acknowledge the following colleagues who contributed significantly to the first two editions of this publication: Dr. Alfred H. Krezdorn [deceased], Dr. David P. H. Tucker and Mr. Charles O. Youtsey.

The last edition of this guide was published in 2006. Much has changed since then in the Florida citrus industry mostly because of the discovery and spread of the bacterial disease, Huanglongbing [HLB]. Rootstocks were not initially part of the discussion related to managing HLB, but that, too, has changed particularly given the accumulating evidence that trees on various rootstocks may differ in the incidence of the disease. Therefore, the authors have prepared this timely and necessary update of the former edition as well as considerably expanding the list of rootstocks to include many that have not yet undergone the usual extensive field evaluation in Florida. These new rootstocks offer improvements of many meaningful traits, such as tree size control, high yield and juice quality and possible HLB tolerance that appear essential to the future of our citrus industry.

- **Notes on** Rootstock Traits
- **Obtaining** the UF rootstocks shown in the table as UFR

**Show/Hide Columns** Columns

Print Table to PDF

Show entries

| Rootstocks | | | Horticultural Traits | | | | | | | Tolerances | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rootstock | Year of first avail. | Seed Prop | Tree Size | Spacing | Yield per Tree | Yield per Acre | Juice Quality | Fruit Size | Salinity | High pH | Clay Soil | Wet Soil | Drough |
| ⊞ | x-639 (Cleo x Rubidoux TF) | 1994 | G | Lg | 8-12 | I | I-H | H/H | I | G | [I] | [G] | [G] | ? |
| ⊞ | C-35 citrange | 1994 | G | I | 8-10 | I | I-H | H/I | I | [P-I] | P | [P] | [I] | ? |
| ⊞ | Carrizo | 1932 | G | Lg | 8-12 | H | I-H | I-H/I | I-Lg | P | P | P | I | G |

UF | IFAS UNIVERSITY of FLORIDA

https://crec.ifas.ufl.edu/extension/citrus_rootstock/explore.html

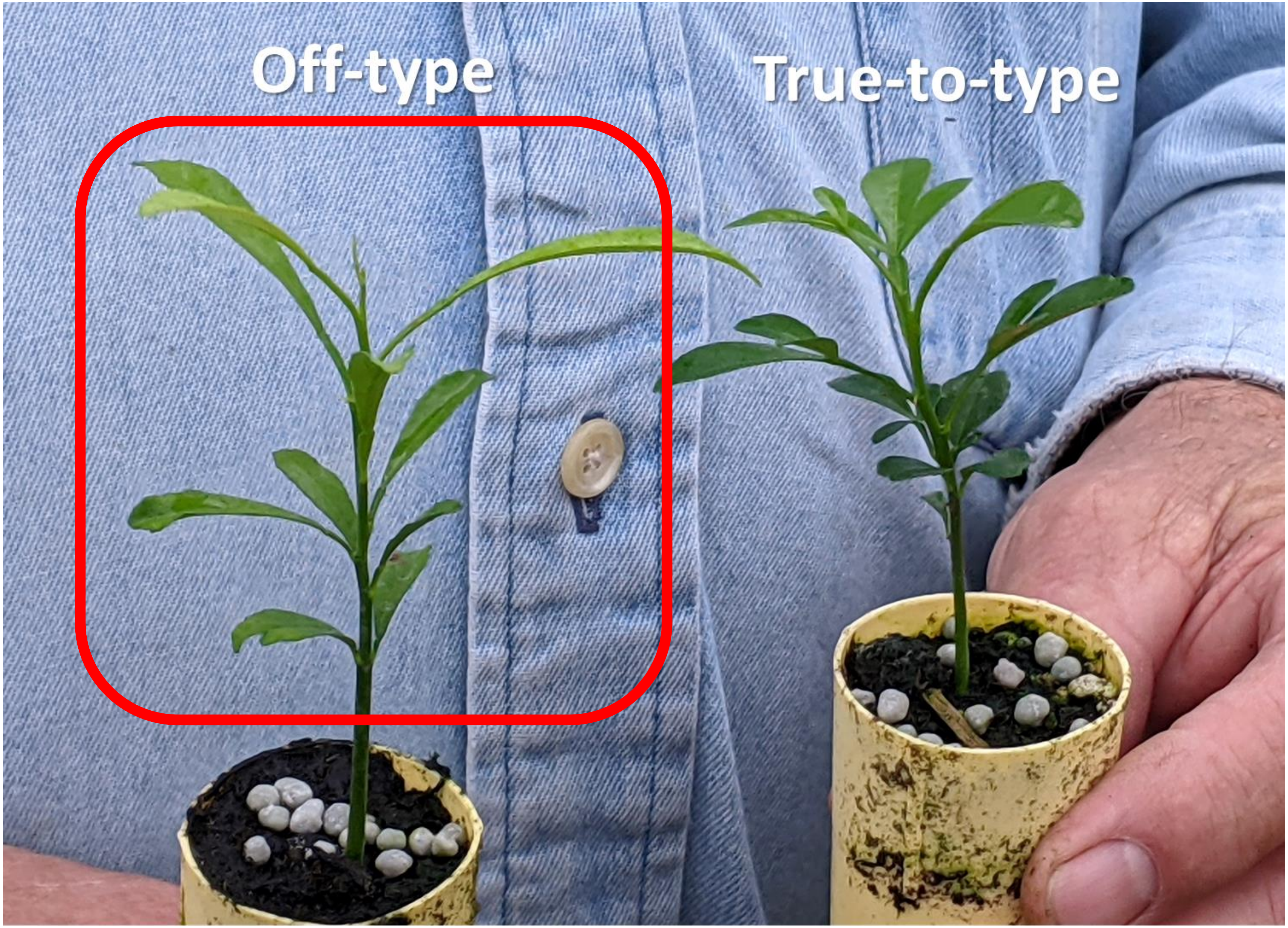
# Seed propagation

**Nucellar embryony (polyembryony)**

Genetically identical embryos develop from the nucellar tissue

# The rootstock

The rootstock



The rootstock

# Cuttings and tissue culture propagation

*Photo credit: Beth Lamb, Phil Rucks Nursery*

Both methods produce genetically identical plants

Propagation

# Tissue culture propagation

Fast year-round production of uniform plants

The rootstock

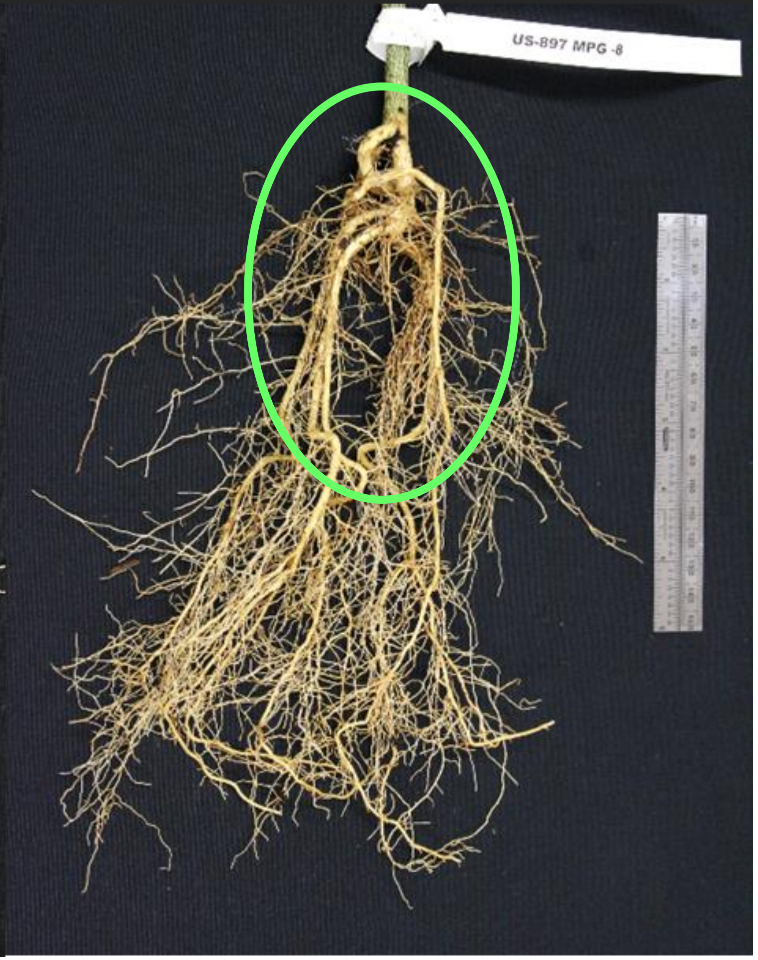
# Root systems

# Field-ready plants

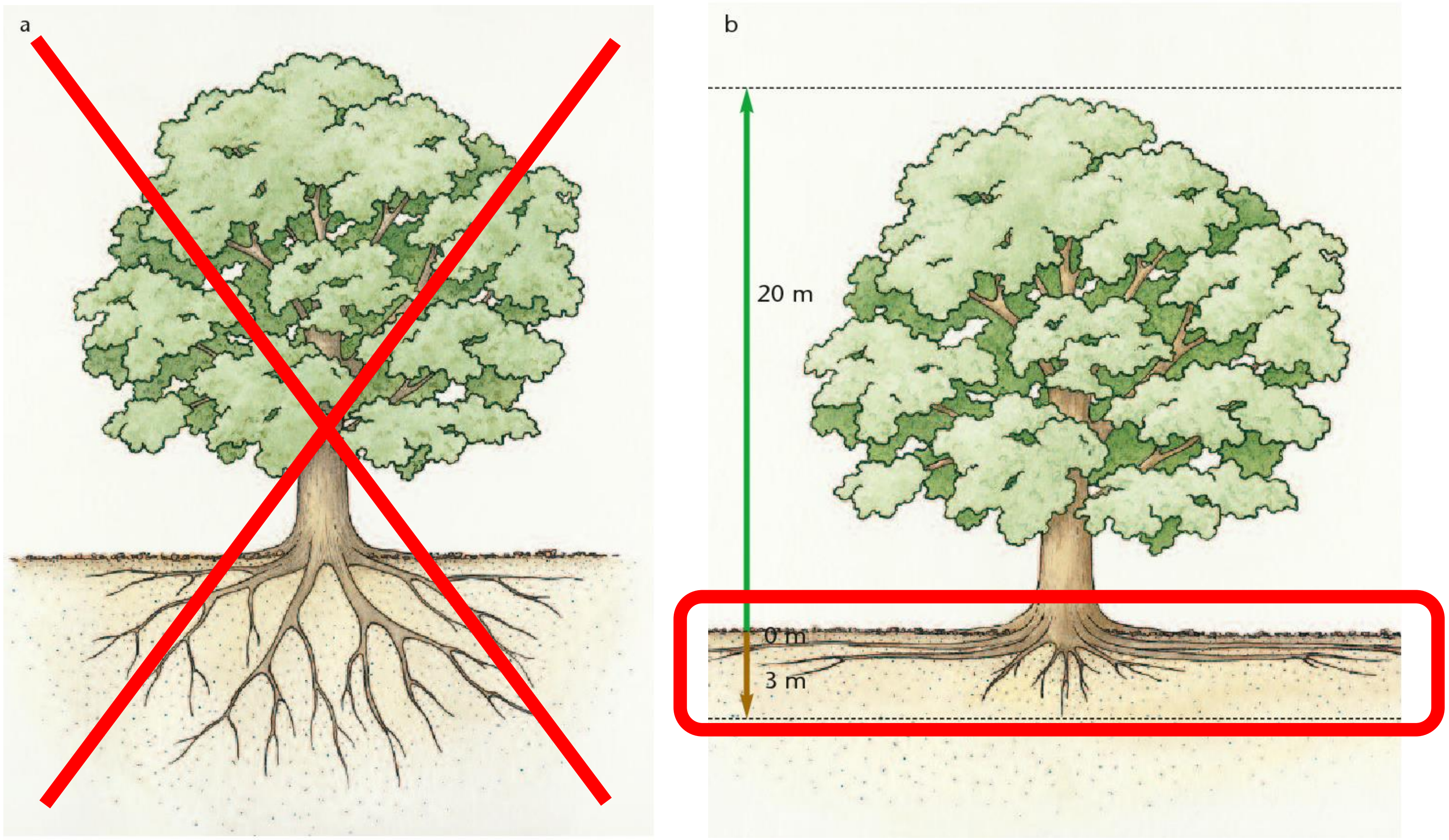
Seed

Cutting

Tissue culture



# Field




Common perception of a tree's root system

More realistic representation

Crow 2005

# Roots extend well beyond the canopy perimeter (drip line)

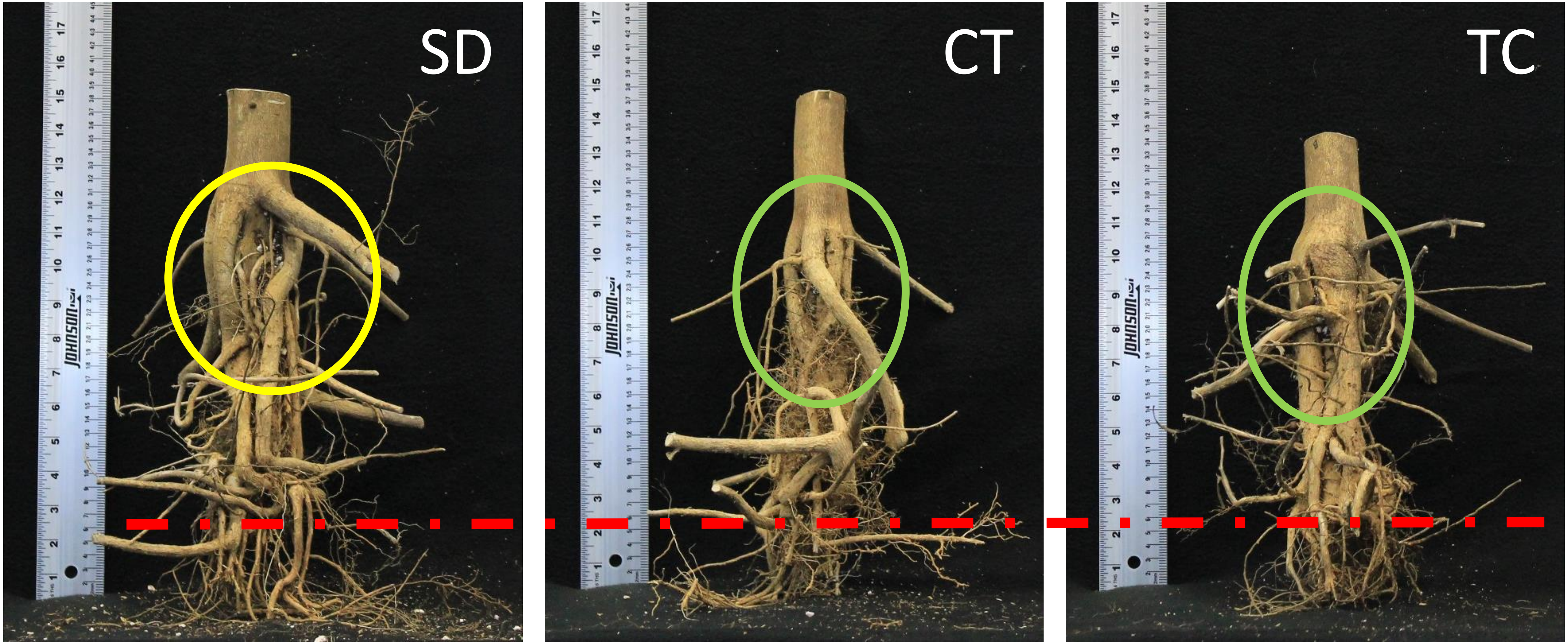
The rootstock

The rootstock

# Root crowns

The rootstock

# Root crowns



# Soil properties

Soil properties

## Mechanical resistance

Roots are unable to grow into soils of high bulk density/compacted soils (e.g., fine sands, clays)

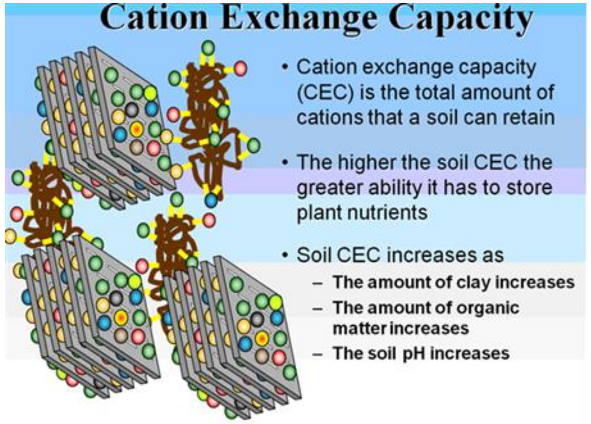
## Aeration

Roots need oxygen to respire and produce energy (flooded and compacted soils have little oxygen)

Soil properties

# Fertility

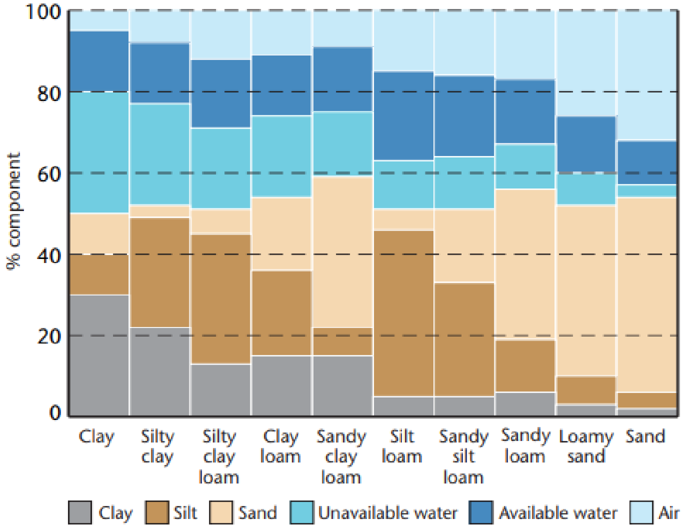
Infertile soils produce long poorly branched roots. Fertile soils produce more vigorous well-branched roots that may descend deeper into the soil




https://www.tankonyvtar.hu/en/tartalom/tamop425/0032_talajtan/ch05s03.html

# Moisture

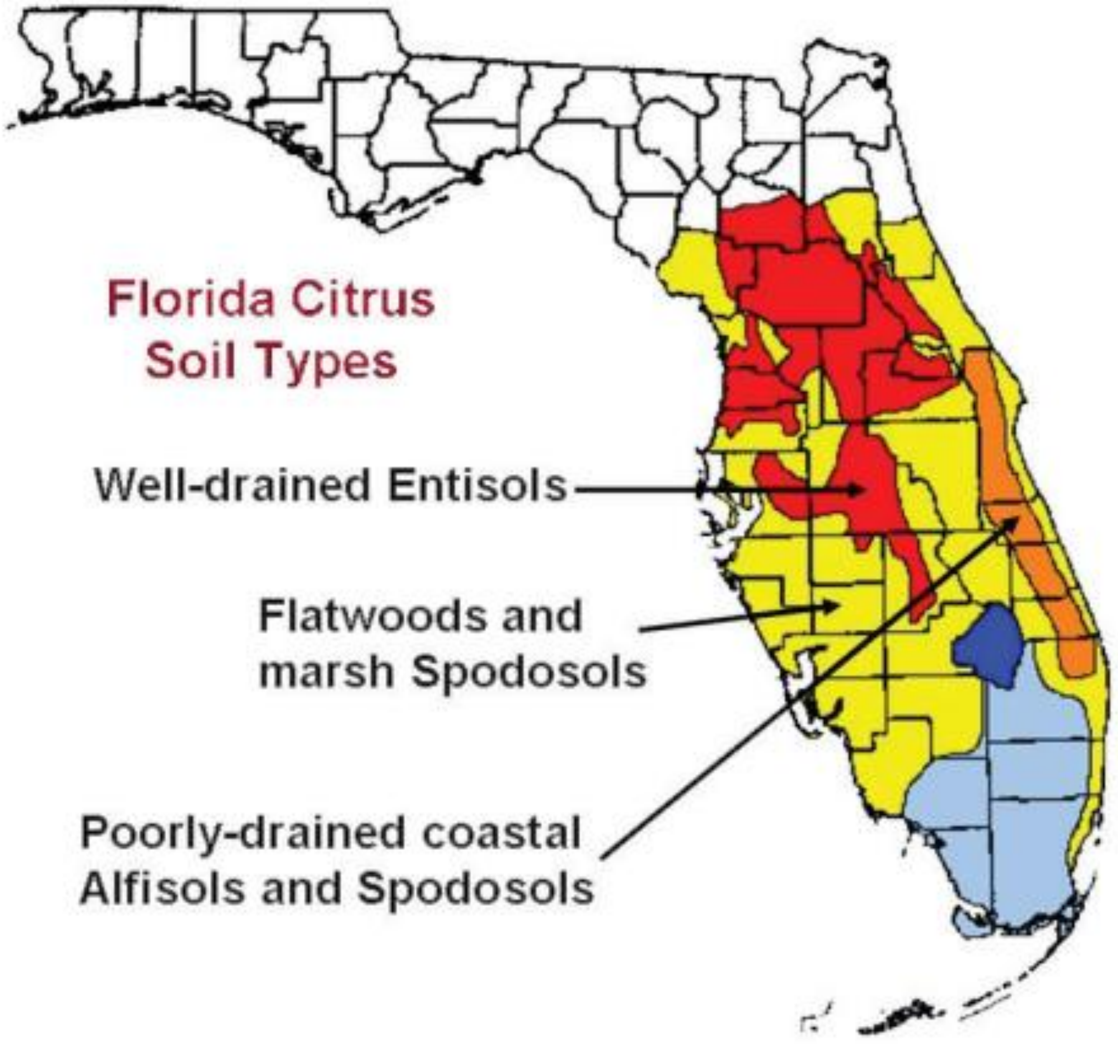
Waterlogged soils create anerobic conditions causing root death. Wet soils create shallow and wide-spread root systems




Crow 2005

Soil properties

# Florida soils




- Sandy (> 98%) with little organic matter (< 0.6%) and a low CEC (< 5 meq/100g)
- Well-drained on the central Florida Ridge
- Poorly drained in SW Florida and the east coast

# Well drained sandy soil

Soil properties

# Poorly drained soils

Soil properties

# Drainage

https://edis.ifas.ufl.edu/publication/CH165

Soil properties

# Poorly designed drainage system

# Soil properties

# Other factors

# Transplanting

- Inspect trees before purchasing and planting!
- Plant trees on the same day they are received
- Do not allowed trees to dry out!
- Loosen the potting medium to expose roots to the soil

Other factors

# Transplanting

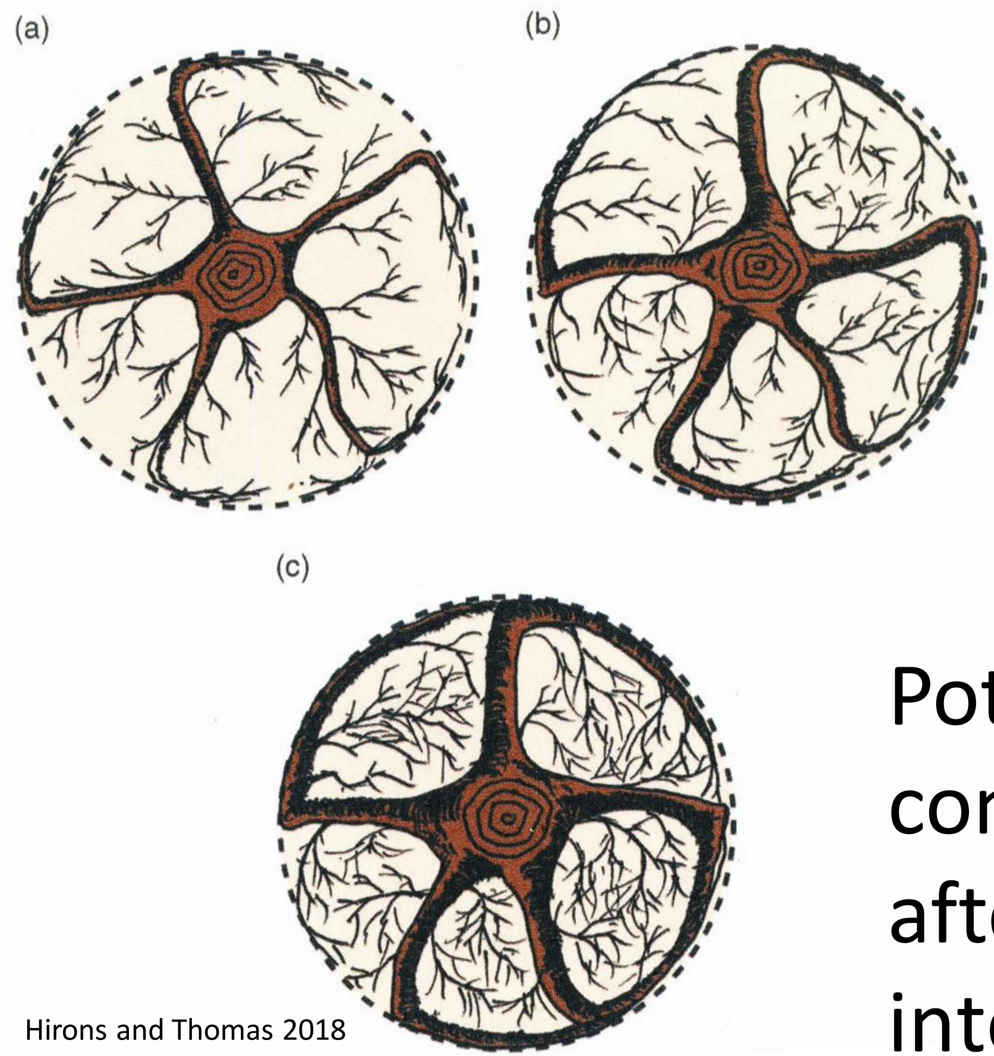
- Pot-bound roots need to be pruned/slashed to encourage new growth
- Plant roots so they are in direct contact with the surrounding soil

- Plant trees slightly above the surrounding soil (do not bury the graft union)
- Don’t throw fertilizer in the planting hole

- Water-in trees immediately after planting

Other factors

# Pot-bound roots

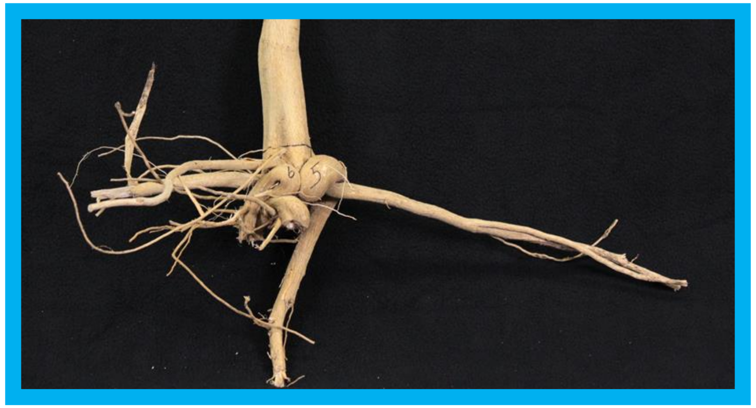


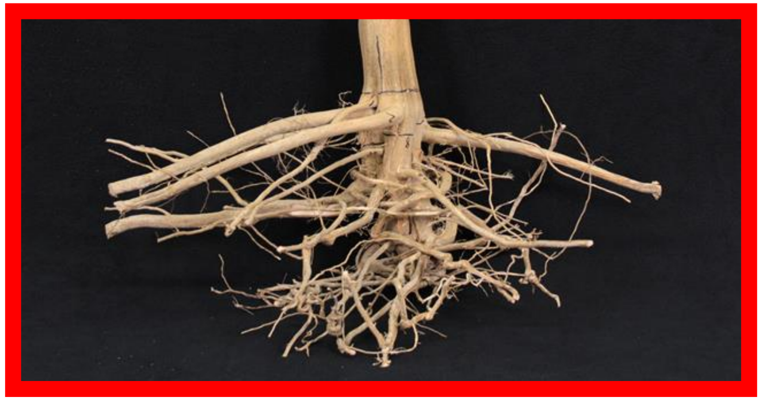

Hirons and Thomas 2018

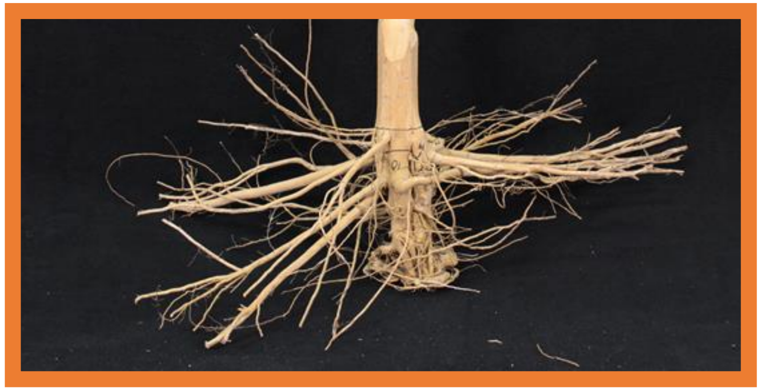
Pot-bound roots will continue to circle after transplanting into the field!

# Pull-over studies to assess wind resistance

# Other factors








# Pot-bound roots

# Other factors


# Other factors

Other factors

# Eucalyptus trees have long roots!

# Frost protection

Location

# The Great Freezes and the Collapse of the Florida Citrus Industry

The devastating winter of 1894 and 1895 dashed the dreams and fortunes of many new Florida settlers. Decades would pass before the state fully recovered.

Florida farmers surveying damage after the great freezes (1894–95)

# The Road To The Caloosahatchee

## The Explosive Growth Of The Citrus Industry In Southwest Florida

By John A. Attaway

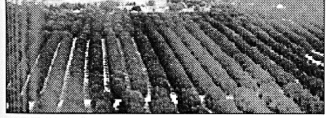
In colonial times, the Florida citrus industry had set its roots along the St. Johns River in northeast Florida. Over a period of years, the industry moved south, first to the lakes and hills of the central Florida ridge, to the Indian River, to the Peace River Valley, and finally, to the banks of the Caloosahatchee — a river that flows from Moore Haven on Lake Okeechobee, through Glades, Hendry, and Lee counties to empty into the Gulf of Mexico at Fort Myers.

Let's look at the factors which led to this final and massive move to southwest Florida, which began in the mid-1960s.

Total citrus acreage planted in Hendry, Collier, and Lee counties from 1962 to 1997, by three-year increments.

| Period | Acreage Hendry | Collier | Lee |
|---|---|---|---|
| Before 1962 | 1491 | 631 | 1591 |
| 1962-65 | 14,491 | 1974 | 417 |
| 1966-69 | 7011 | 2423 | 5427 |
| 1970-73 | 2630 | 290 | 432 |
| 1974-77 | 7160 | 652 | 569 |
| 1978-81 | 5502 | 2155 | 1924 |
| 1982-85 | 10419 | 3168 | 1480 |
| 1986-89 | 30,660 | 13,730 | 3020 |
| 1990-93 | 24,419 | 9720 | 3609 |
| 1994-97 | 7527 | 1510 | 631 |

Source: Florida Agricultural Statistics Service



### Caloosahatchee History

First, it should be pointed out that citrus was not new to southwest Florida when the first central Florida growers moved south. Citrus fruit had been grown in Lee and Hendry counties for over 80 years, but on a much smaller scale than today.

According to the *Ft. Myers News-Press*, March 15, 1966, oranges were planted near Alva in 1877 and along the river in North Ft. Myers in 1885. Files at the Ft. Myers Historical Museum show that 15,000 boxes of fruit were shipped from the area prior to the great freeze of 1894–95, which destroyed the north Florida crop. Demand for southwest Florida fruit increased after the freeze, when 40,000 boxes were shipped during the 1895–96 season, and 70,000 boxes in 1896–97. In those days, growers used river steamers on the Caloosahatchee to bring their fruit downstream to Ft. Myers, just as northeast Florida growers had used the St. Johns River to bring their fruit to Jacksonville.

In the early 1900s, some speculated that the Caloosahatchee basin would grow to be the "orange and grapefruit section of the world." However, growth was slow. Labelle continued to be a sleepy little cattle town well into the 20th century. The prediction that southwest Florida would become a dominant citrus-producing region has only come about over the last 30 years. Prior to 1965, the bearing acres of citrus of all varieties in Hendry County totaled only 1491 acres, and in Lee County, 1591 acres. In contrast, Polk and Lake counties grew 127,629 acres and 106,627 acres, respectively.

### Freeze Pressure

At this point in history, two things became apparent after an extremely severe freeze in 1962 destroyed a major portion of the central Florida crop. One, the groves in Lake and Polk counties were very vulnerable to cold and could not guarantee a full crop every year. And two, there was no longer room for expansion in the traditional citrus-growing areas of central Florida. A grower's outlook on the shortage of land was well expressed by J. R. "Bob" Paul of Winter Haven in a conversation with his son Gene in the 1960s: "Gene, there aren't any big tracts of good citrus land left in Polk County. We've

*continued on page 52*

# Microsprinklers

# Trunk protection

http://citrusindustry.net/2016/10/05/evaluation-of-tree-t-pees-for-freeze-protection-in-young-citrus/

Location

# Factors affecting freeze tolerance

- Grove location and topography
- Minimum air temperature and duration
- Freeze acclimation
- Species and cultivar of scion and rootstock
- Condition of the tree and (vigor and growth stage; previous cultural practices)
- Presence/absence of overhead or ground cover

# Cultivar tolerance

Freeze tolerance is highest in trifoliate orange (*Poncirus trifoliata*)

**Trifoliata > Kumquat > Sour orange > Mandarin > Sweet orange > Grapefruit > Pummelo > Lemon > Lime > Citron**



Pre-hardening is necessary to achieve protection

# Thank you


Ute Albrecht
ualbrecht@ufl.edu
UF | IFAS
UNIVERSITY of FLORIDA